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AN ANALYSIS
OF THE
ELECTRICAL TRADE
• CONSTRUCTION •



PREPARED BY
A NATIONAL COMMITTEE
APPOINTED BY
THE DEPARTMENT OF LABOUR
OTTAWA, CANADA
1958

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AN ANALYSIS OF THE ELECTRICAL TRADE

(CONSTRUCTION)

INTRODUCTION

The first National Conference on Apprenticeship in Trades and Industries held at Ottawa in May 1952 recommended that the Federal Government be requested to cooperate with provincial apprenticeship committees and others concerned in preparing analyses of a number of skilled occupations. In implementing this recommendation, the Vocational Training Branch of the Federal Department of Labour has appointed a number of committees, each of which has compiled an analysis of one trade.

In the case of the Electrical Trade a committee of three experienced teacher-tradesmen was appointed and the organization meeting was held in Montreal on September 30, 1957. Mr. S. P. Didcote, Shop Director, Manitoba Technical Institute, Winnipeg, was named to represent the four western provinces; Mr. D. E. Clack, Shop Director, Ridgemont High School, Ottawa, represented central Canada and the third member representing the four maritime provinces was Mr. Reuel I. Smith, Instructor in Construction Wiring at the Halifax County Vocational High School, Halifax, N.S. The Committee was convened by Mr. S.R. Ross, Supervisor of Trade Training, Department of Labour, Ottawa, Ontario.

SCOPE OF THE ANALYSIS

In considering the electrical trade it is apparent that the journeyman is not required to make or produce component parts as in the case of some other trades. However, this trade is a two-fold activity. On one hand it involves installation techniques and on the other hand knowledge of scientific principles and their application. Based upon the use of electricity there are many activities of a special nature such as radio and television servicing, the repairing of motors, generators and transformers, not to mention the field of electronics of which the public hears much at this time. There are, as well, other specialties such as telephone work, elevator installing and the like. Having all these circumstances in mind, the Committee decided to define the area of the electrical trade as indicated in the following.

In general, this trade is considered as incorporating all operations, including testing and minor servicing, required in installing a complete and comprehensive system which uses electricity as the source of light, heat and power required for modern structures such as schools, hospitals or office buildings. This work begins at the point where the local power company terminates the primary service in the usual transformer vault or outside yard. Included in such systems are certain special facilities such as fire alarms, clocks, bells and public address systems. In addition, any other features that are found in good house wiring are included. Broadly, the foregoing sets forth the field of work which comprises the construction electrical trade in each and every province and beyond this scope the journeyman need not go to secure top rating. The committee suggests that the journeyman in the construction field be designated by the single word, 'electrician' and that 'electrical trade' imply activities in the field of work as indicated above.

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This analysis anticipates that the electrician will be trained to design and lay out any system using secondary services for buildings of the class of single or small multi-unit residences and the like. In addition it is intended that he will be proficient in executing and completing details of the electrical installation as required by the plans and specifications for buildings of the larger and more complex types. Involved in this of course will be the interpreting of instructions and details provided by the manufacturers of miscellaneous equipment.

Having these various features in mind, the committee endeavoured to include all operations that are considered essential and common to all provinces. Apprenticeship officials in each province have agreed that the operations and related knowledge set forth are complete as the basis of a training program for apprentices.

It should be noted that this analysis is not a course of study nor is it intended that operations be undertaken in the sequence shown. It is, however, a compilation of essential operations in the mechanical and installation phases of this trade which a journeyman should be able to perform and includes those items of basic science, mathematics and other related knowledge which he must master to enable him to execute those operations in a skilful and analytical manner.

There is a broad body of techniques and information that form a background to this trade. Many such features are self-evident and it is taken for granted that they would be included in a well planned trade-training program. Therefore it was decided not to indicate these repeatedly throughout the analysis but, nevertheless, their importance is emphasized here with the thought that they will be enlarged upon in courses of study based on this analysis. Some of these topics are good public and customer relations, cleanliness and orderliness, care of hand and power-driven tools, safety of the individual and his fellow employees, proper procedures to guard against damage to supplies and equipment before and after installation.

The apprentice should be trained so as to know good workmanship and to gain an intimate knowledge of the Canadian Electric Code inasmuch as this provides a broad basis of requirements province to province. In this analysis due regard has been given to the fact that in certain provinces there are exceptions to the Code. These of course should be made familiar to the trainee in those provinces. At the same time the apprentice should become conversant with procedures necessary to assure that equipment and supplies used meet provincial or other requirements.

PROCEDURE

At the outset, the Directors of Apprenticeship agreed to have their provinces represented as indicated above. This ensured that the final compilation would be generally acceptable and would be considered as the basis of instruction of apprentices.

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Each committee member agreed to compile a main division of the analysis and to refer his work, as it progressed, to the others for critical examination. It was felt that this procedure would ensure the validity of each part and guarantee the national aspect of the whole.

Finally, proof-copies of the completed work were distributed to Directors of Apprenticeship and to many others for general review before publishing in printed form.

PURPOSES AND USES OF THE ANALYSIS

The Committee recommends this analysis as a guide to foremen and others who do training on the job; as the basis for courses of study for apprentice schools and other centres; as the standard on which the competency of newcomers or others may be evaluated.

It is the sincere hope of the Committee that this effort will contribute to the nation-wide development of apprenticeship training and will generate real zeal for a uniformly high standard of craftsmanship in this trade.

The Committee desires to express its appreciation to officials of the Training Branch of the Department of Labour, Ottawa, to the Directors of Apprenticeship and all who contributed to the completion of this analysis.

AN ANALYSIS OF THE ELECTRICAL TRADE (CONSTRUCTION)

ROUGHING-IN PROCEDURES

BLOCK 1: General Trade Practice

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AN ANALYSIS OF THE ELECTRICAL TRADE (CONSTRUCTION)

ROUGHING-IN PROCEDURES

BLOCK 1: General Trade Practice

UNIT 1: Operations Requiring Hand Tools

OPERATIONS	KNOWLEDGE
<hr/>	
1. Installing a screw in wood or metal	(a) Types and sizes of screws (b) Use of standard, Robertson, Phillips screw drivers
2. Cutting, holding and forming wires	(a) Common types of pliers and cutters and their use
3. Tightening a nut or bolt	(a) Types of wrenches and their use
4. Coupling rigid conduit	(a) Pipe wrenches and their use (b) Types and sizes of coupling
5. Chisel a hole in wood, metal, concrete or masonry	(a) Sizes and types of hammers and their use (b) Types and sizes of chisels
6. Skinning wire	(a) Recommended type and size of jackknife and its use (b) Use of cable ripper and wire strippers
7. Honing cutting edge	(a) Oil stones and their use
8. Cutting out for switch box in finished wall	(a) Methods of using hacksaw blade and keyhole saw (b) Use of routing bit
9. Sawing lumber as required	(a) Types of hand saws and their use e.g. crosscut and rip (b) Use of the square
10. Cutting armour on armoured cable	(a) Types of metal cutting saws and their use (b) Teeth per inch to suit job (c) Direction of cut

AN ANALYSIS OF THE ELECTRICAL TRADE (CONSTRUCTION)

ROUGHING-IN PROCEDURES

BLOCK 1: General Trade Practice

UNIT 1: Operations Requiring Hand Tools

OPERATIONS	KNOWLEDGE
<hr/>	
11. Measuring length of conduit	(a) Methods of measuring without a rule (b) Measuring with a rule
12. Cutting and reaming rigid conduit by hand	(a) Use of one and two wheel pipe cutters (b) Method of cutting with hacksaw (c) Methods of reaming with reamer file (d) Use of brace reamer and ratchet reamer
13. Threading conduit by hand	(a) Construction of dies and how they cut a thread (b) Operating techniques to prevent die damage (c) Cutting oils and the reason for their use (d) Advantage of sharp dies (e) Use of dies and stocks from $\frac{1}{8}$ " to 2" capacity (f) Oil cans and their care
14. Boring a hole in wood by hand	(a) Care and use of the bit brace (b) Knowledge of one and two spur bits and their correct use (c) Use of bit file and methods of sharpening bits (d) Types and use of bit extensions
15. Cutting hole for conduit in metal panel by hand	(a) Method of using hole saws (b) Correct use of knockout punches (c) Sizes of holes to receive conduit sizes (d) Techniques of enlarging and reducing holes in panels
16. Locating outlets on ceiling from floor	(a) Use of chalk and chalk lines (b) Method of using plumb bob
17. Leveling floor boxes in concrete floor slab form	(a) Use of chalk line and line levels (b) Types and use of levels (c) Use of straight edges

AN ANALYSIS OF THE ELECTRICAL TRADE (CONSTRUCTION)

ROUGHING-IN PROCEDURES

BLOCK 1: General Trade Practice

UNIT 1: Operations Requiring Hand Tools

OPERATIONS	KNOWLEDGE
<hr/>	
18. Fishing wires in conduit	(a) Use and care of fish tape (b) Procedure when lacking fish tape (c) Use of snake
19. Drawing large conductors in conduit	(a) Use of equipment for drawing-in wires e.g. Come-along, block and tackle, chain falls (b) Types and use of cable grips (c) How to make a cable grip
20. Measuring size of wire	(a) Use of wire gauge and micrometer
21. Fastening lug to wire	(a) Use of special lug and connector pliers
22. Cutting sheet metal for blanking panel knockouts	(a) Use of tin snips
23. Soldering wire connection	(a) Use and care of torches (b) Types and use of soldering irons (c) Use of soldering pot
24. Bending rigid conduit by hand	(a) Types of conduit hickies and their correct use to prevent damage to conduit
25. Bending thinwall conduit by hand	(a) Types of E.M.T. bender and its use
26. Bending wiremold conduit	(a) Use of wiremold bender
27. Drilling hole in concrete wall by hand	(a) Star drills and their use (b) Special drills and their use
28. Boring hole in wood or plaster for bell wire	(a) Sizes of bell hangers' drills and their use (b) Use of bell hangers' bit for easy pulling

AN ANALYSIS OF THE ELECTRICAL TRADE (CONSTRUCTION)

ROUGHING-IN PROCEDURES

BLOCK 1: General Trade Practice

UNIT 1: Operations Requiring Hand Tools

OPERATIONS	KNOWLEDGE
<hr/>	
29. Tapping hole for mounting bolt	(a) Types and use of tap handles (b) Tap drill sizes (c) Body sizes (d) Taper and bottom taps and their correct use
30. Cutting taper on core duct conduit	(a) Interpreting manufacturers' instruction sheets when using special tools and equipment
31. Making hanger bolt	(a) Use of block dies and stocks (b) Stock diameter for threading
32. Painting out-door run of conduit	(a) Care and use of paint brushes (b) Knowledge of paints and paint thinners used in the trade (c) Method of painting conduit without splattering building
33. Fishing across a ceiling or wall	(a) Care and use of fish tapes (b) Use of heavy wire in place of fish tape (c) Improvised fishing methods
34. Tightening an Allen set screw in a solderless lug	(a) Types and sizes of Allen set screw wrenches and their use

AN ANALYSIS OF THE ELECTRICAL TRADE (CONSTRUCTION)

ROUGHING-IN PROCEDURES

BLOCK 1: General Trade Practice

UNIT 2: Operations Requiring Power Tools

OPERATIONS	KNOWLEDGE
<hr/>	
1. Drilling mounting hole in panel	(a) Sizes and use of electric drills (b) Twist drill sizes (c) Method of sharpening twist drills and cutting angle
2. Drilling holes in concrete with power tools	(a) Sizes and use of masonry drills (b) Method of using electric hammer (c) Method of sharpening masonry drills
3. Threading conduit by machine	(a) Methods of using pipe threading machine (b) Use and care of dies and stocks over 2" capacity
4. Shooting 'stud' in concrete wall	(a) Method of using stud guns and safe handling of explosives (b) Sizes of charges used
5. Grinding edge on a chisel	(a) Types of grinding wheels (b) Metal temper and grinding precautions (c) Proper use of grinding wheel to prevent damage to grinding surface (d) Goggles, protective shields (e) First aid for injured eye
6. Sawing as required	(a) Types of chain saws and their use and care (b) Types of portable circular saws and their use

AN ANALYSIS OF THE ELECTRICAL TRADE (CONSTRUCTION)

ROUGHING-IN PROCEDURES

BLOCK 1: General Trade Practice

UNIT 3: Operations Requiring Portable Equipment

OPERATIONS	KNOWLEDGE
<hr/>	
1. Mounting a ceiling light fixture	(a) Use and care of a step ladder (b) Care necessary when setting up ladder
2. Installing conduit on side of building	(a) Method of carrying and setting up ladder (b) Care in securing and working off ladder (c) Right and wrong working side of ladder
3. Hanging fixture tubs in a warehouse	(a) Types of portable steel staging (b) Procedures in setting up and taking down staging
4. Setting up a bench vise to thread heavy conduit	(a) Types of yoke and chain vises (b) Method of securing to bench
5. Setting up tri-stand vise to thread and bend conduit	(a) Types of tri-stand vises (b) Method of securing vise to ceiling with conduit (c) Method of bending $\frac{1}{2}$, $\frac{3}{4}$ and 1 inch conduit in vise stand (d) Care of vise jaws
6. Bending conduit larger than $\frac{3}{4}$ inch	(a) Method of using hydraulic bending machine (b) Strain limits to prevent kinking conduit
7. Setting up reel stand	(a) Use of hydraulic jacks (b) Method of securing stand (c) Method of lifting large reels

AN ANALYSIS OF THE ELECTRICAL TRADE (CONSTRUCTION)

ROUGHING-IN PROCEDURES

BLOCK 1: General Trade Practice

UNIT 4: Hazardous Procedures

OPERATIONS	KNOWLEDGE
<hr/>	
1. Lifting extension ladder into place	(a) Safe methods of lifting heavy equipment (b) Lifting limitations with safety
2. Operating power equipment	(a) First-aid methods and injury reports (b) Safe personal working habits while operating power vise, 'stud' gun and centrifugal units (c) Use and importance of safety signs (d) Use and care of goggles (e) Use of equipment ground for prevention of shock
3. Working on high ladder	(a) Safe reaching limits from ladder (b) Use of safety belts (c) Methods of securing ladder
4. Working on live equipment	(a) Use of safety equipment e.g. Rubber mats, sleeves and gloves (b) Symptoms of electric shock (c) Procedures in artificial respiration
5. Preventing and/or extinguishing a fire	(a) Method of sending in fire alarm (b) Types and use of fire extinguishers (c) Methods of preventing fires while performing trade operations e.g. while using blow torch

AN ANALYSIS OF THE ELECTRICAL TRADE (CONSTRUCTION)

ROUGHING-IN PROCEDURES

BLOCK 1: General Trade Practice

UNIT 5: Fastenings and Connectors

OPERATIONS	KNOWLEDGE
<hr/>	
1. Installing and using securing devices	(a) Types and number threads per inch (b) Types of heads e.g. flat, oval, round (c) Various devices such as toggle bolts, plugs, lag screws, tamp-ins
2. Using various washers	(a) Common washers used e.g. reducing, flat, lock (b) Purposes of various types
3. Determining the proper screw	(a) Types and sizes of wood and sheetmetal screws (b) Recommended screw size to meet load requirements
4. Using locknuts and bushings	(a) Use of locknut to make mechanical and electrical bond (b) Use of bushing to protect insulation
5. Soldering metals	(a) Steps in cleaning and tinning soldering irons (b) Types and use of fluxes (c) Types of solder and their applications on different metals
6. Installing a solder-less lug or connector	(a) Current ratings of lugs (b) Wire size rating of lugs (c) Methods of installing
7. Taping a joint	(a) Dielectric strength (b) Use of compound and friction tape (c) Methods of applying tape (d) Use of other insulating materials e.g. scotch, electric tape, varnished cambric
8. Installing cable connectors	(a) Knowledge of the various types (b) Methods of using cable connectors
9. Securing conduit and/or cable	(a) Types and use of one hole and two hole straps

AN ANALYSIS OF THE ELECTRICAL TRADE (CONSTRUCTION)

ROUGHING-IN PROCEDURES

BLOCK 1: General Trade Practice

UNIT 6: Miscellaneous Operations

OPERATIONS	KNOWLEDGE
<hr/>	
1. Removing floor boards and cutting pocket for fishing	(a) Method of removing tongue from tongue and groove flooring (b) Method of starting saw to cut finish flooring (c) Method of cutting sub-floor (d) Method of replacing sub and finish floor after wiring is completed
2. Removing base board and/or door casings to facilitate fishing of wires	(a) Method of removing base and casings without injury to wood (b) Method of replacing base and casings without damaging wood
3. Stopping a leak caused by puncturing a concealed water pipe	(a) Locating main shut-off valve (b) Locating line shut-off valves (c) Desirability of locating hidden water pipes

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ROUGHING-IN PROCEDURES

BLOCK 2: Boxes

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AN ANALYSIS OF THE ELECTRICAL TRADE (CONSTRUCTION)

ROUGHING-IN PROCEDURES

BLOCK 2: Boxes

UNIT 1: Sectional Switch Boxes

OPERATIONS

KNOWLEDGE

- | | |
|---|--|
| 1. Mounting sectional box on a stud | (a) Reading blue prints and specifications to determine location and details of wall
(b) Methods of fastening boxes of various types with screws, nails and attachments
(c) Approved types and sizes of boxes available
(d) Dimensions of box relative to number and size of conductors
(e) Method of removing box knockouts
(f) Method of adjusting box ears |
| 2. Installing sectional box on bar hangers | (a) Types and use of bar hangers
(b) Method of ganging boxes
(c) Method of fastening box to bars and bars to studs |
| 3. Mounting boxes between studs on board support | (a) Methods of measuring, cutting and fastening wood support
(b) Care to mount plumb, level and square
(c) Reason for complete cooperation with other trades e.g. assistance from carpenters |
| 4. Cutting out for and installing a sectional box in a finished, plastered or panelled wall | (a) Steps in locating studs, angle braces and obstructions in wall before cutting box hole
(b) Trade techniques in dealing with wallpaper, old plaster and new plaster
(c) Method of cutting box opening in wall of plaster on various bases
(d) Care in cutting minimum opening
(e) Elements of good customer relations
(f) Method of securing box by ears |

ROUGHING-IN PROCEDURES

BLOCK 2: Boxes

UNIT 2: Octagon boxes

OPERATIONS	KNOWLEDGE
<hr/>	
1. Installing four inch octagon box as a flush outlet	(a) Types and construction of octagon boxes (b) Dimension of box relative to number and size of conductors (c) Methods of mounting on joist or rafter, on board between joists, on bar hangers, etc
2. Installing four inch octagon box on the surface	(a) Methods of securing boxes to building finish, such as wood, plaster and lath, hollow tile and plaster, concrete, brick, metal lath and plaster, etc (b) Suitable covers for job
3. Extending flush box to a surface box for additions and alterations	(a) Types and uses of extension boxes (b) Methods of installing an extension box

ROUGHING-IN PROCEDURES

BLOCK 2: Boxes

UNIT 3: Square Outlet Boxes and Plaster Rings

OPERATIONS	KNOWLEDGE
<hr/>	
1. Installing square outlet box on the surface	(a) Types and sizes of boxes used (b) Dimensions of box in relation to size and number of conductors (c) Same mounting skills as for octagon box
2. Roughing-in square outlet box in a hollow tile wall or partition	(a) Method of supporting box on conduit from above before wall is built (b) Necessary care to ensure box being mortared in place level and plumb (c) Methods of providing temporary support by bar hanger, wire, angle iron
3. Roughing-in square outlet box in wood or masonry partition	(a) Skills and knowledge used in mounting octagon box
4. Preparation of square boxes before plastering wall	(a) Types and sizes of plaster rings and their use (b) Minor adjustments of plaster ring to compensate for out-of-plumb box

ROUGHING-IN PROCEDURES

BLOCK 2: Boxes

UNIT 4: Concrete Boxes and Covers

OPERATIONS	KNOWLEDGE
<hr/>	
1. Securing octagon box to concrete forms and to the conduit	<ul style="list-style-type: none">(a) Blueprint reading to determine box location(b) Care needed to prevent concrete entering boxes(c) Reading specifications and blueprints to determine details of construction(d) Types and sizes of boxes and their use(e) Method of securing box to conduit and to form(f) Sizes and use of bushings to keep concrete out of conduit(g) Types of box covers and their use
2. Securing square box to the form as a switch or receptacle outlet	<ul style="list-style-type: none">(a) Method of securing box to form after box has been fastened to the conduit(b) Method of removing a knockout after the box has been fastened to the form

AN ANALYSIS OF THE ELECTRICAL TRADE (CONSTRUCTION)

ROUGHING-IN PROCEDURES

BLOCK 2: Boxes

UNIT 5: Junction and Pull Boxes

OPERATIONS	KNOWLEDGE
<hr/>	
1. Installing standard box as a pull box or junction box	(a) Blank covers available for standard boxes and their use (b) Dimensions of box in relation to number and size of conductors (c) Recommended distance between pull points
2. Installing a type-E cabinet as a pull or junction box	(a) Types and sizes of type "E" cabinets (b) Number of wires and/or joints permissible in various boxes (c) Method of supporting "E" cabinets
3. Installing gutter box	(a) Types and sizes of gutter boxes (b) Number of wires and/or joints permissible in various sizes (c) Method of supporting large gutter boxes
4. Installing specially constructed pull or junction box	(a) Required gauge of metal used to fabricate boxes (b) Method of fastening covers and inspection plates (c) Steps necessary to secure approval of such equipment

ROUGHING-IN PROCEDURES

BLOCK 2: Boxes

UNIT 6: Watertight Floor Boxes

OPERATIONS	KNOWLEDGE
<hr/>	
1. Installing non-adjustable floor box as an outlet box or junction box	<ul style="list-style-type: none">(a) Reading plans and specifications to determine type and thickness of rough floor, finish floor and floor covering(b) Method of installing box to exact measurements(c) Types and sizes of non-adjustable floor boxes and their use(d) Types and sizes of accessories for boxes available(e) Use of covers and gaskets and the importance of making box watertight(f) Dimensions of box relative to the number and size of conductors
2. Installing adjustable floor box as an outlet or junction box	<ul style="list-style-type: none">(a) Types and sizes of adjustable floor boxes and their use(b) Method of adjusting box to contour and finish of floor
3. Installing adjustable or non-adjustable floor box as a telephone or signal box	<ul style="list-style-type: none">(a) Reading plans and specifications to determine type of telephone and/or signal system(b) Necessity of co-operation with local telephone company

AN ANALYSIS OF THE ELECTRICAL TRADE (CONSTRUCTION)

ROUGHING-IN PROCEDURES

BLOCK 2: Boxes

UNIT 7: Underground Boxes

OPERATIONS	KNOWLEDGE
1. Installing watertight, cast iron box underground	(a) Method of installing an underground box with special reference to: Frost level, sub-fill, back-fill, trench width and depth (b) Method of filling box with compound (c) Types of waterproof compounds and paints

AN ANALYSIS OF THE ELECTRICAL TRADE (CONSTRUCTION)

ROUGHING-IN PROCEDURES

BLOCK 2: Boxes

UNIT 8: Wiremold Boxes

OPERATIONS	KNOWLEDGE
<hr/>	
1. Installing wiremold box for a switch or receptacle	(a) Types and sizes of wiremold switch and receptacle boxes and their use (b) Methods of installing wiremold boxes
2. Installing wiremold surface extension box to a flush outlet or switch	(a) Types and sizes of wiremold extension boxes and their use (b) Method of installing a wiremold extension box
3. Installing general purpose wiremold box	(a) Types and sizes of general use boxes, such as, corner boxes, utility boxes and junction boxes

AN ANALYSIS OF THE ELECTRICAL TRADE (CONSTRUCTION)

ROUGHING-IN PROCEDURE

BLOCK 3: Fittings

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2: Installing vaportight cover		

ROUGHING-IN PROCEDURES

BLOCK 3: Fittings

UNIT 1: Condulet Fittings

OPERATIONS	KNOWLEDGE
<hr/>	
1. Installing condulets in a building	(a) Knowledge of the types and sizes of condulet fittings to insure the proper selection and use (b) Method of tightening a fitting to conduit (c) Method of connecting condulet fitting to electrical metallic tubing
2. Installing condulets out-of-doors or in damp locations	(a) Method of making a condulet cover watertight (b) Method and reason for cutting a groove in service entrance "LB" condulet (c) Method of painting or covering condulet fitting in special installations
3. Installing explosion-proof and dust-tight condulets	(a) Considerations in selecting fittings required to suit installations in hazardous locations (b) Method of installing explosion-proof, dust-tight fittings (c) Types and use of sealing compounds
4. Installing expansion fitting in a run of rigid conduit	(a) Reading plans and specifications to determine location of expansion fitting (b) Types and sizes of expansion fitting (c) Methods of installing same

AN ANALYSIS OF THE ELECTRICAL TRADE (CONSTRUCTION)

ROUGHING-IN PROCEDURES

BLOCK 3: Fittings

UNIT 2: Wiremold Fittings

OPERATIONS	KNOWLEDGE
<hr/>	
1. Installing wiremold elbow	(a) Types and sizes of internal, external and flat elbows (b) Method of installing wiremold elbows
2. Installing wiremold adapters	(a) Types and sizes of wiremold adapters e.g. to conduit, to cable, to open wiring (b) Method of installing adapters
3. Installing wiremold "Tee" fitting	(a) Wiremold "Tee" fittings, their use and installation methods

AN ANALYSIS OF THE ELECTRICAL TRADE (CONSTRUCTION)

ROUGHING-IN PROCEDURES

BLOCK 3: Fittings

UNIT 3: Vaportight Fittings, Covers
and Accessories

OPERATIONS	KNOWLEDGE
<hr/>	
1. Installing V or VH series vaportight fitting	(a) Use of distributors' catalogues to select fitting required (b) Method of supporting fitting base (c) Method of assembling and disassembling fitting and base
2. Installing type FS and/or FD vaportight cover	(a) Types, sizes and use of vaportight covers and accessories (b) Methods of assembling complete units (c) Gasket materials, compounds and their use

AN ANALYSIS OF THE ELECTRICAL TRADE (CONSTRUCTION)

ROUGHING-IN PROCEDURES

BLOCK 4: Wire and Cable

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AN ANALYSIS OF THE ELECTRICAL TRADE (CONSTRUCTION)

ROUGHING-IN PROCEDURES

BLOCK 4: Wire and Cable

UNIT 1: Inside Open Wiring

OPERATIONS

KNOWLEDGE

1. Repairing knob and tube, cleat wiring system

- (a) Methods of tightening slack in wires
- (b) Types, sizes and use of knobs, tubes and cleats
- (c) Insulating and protecting system
- (d) 'Running' board sizes and installation methods
- (e) Steps in soldering and insulating taps and splices e.g. Western union splice, tee tap
- (f) Methods of making a dead-end in conductors after alterations and additions have been made e.g. Dead-ending circuit feeder after picking up with cable
- (g) Knowledge of surface switches, rosettes, receptacles, lamp holders, etc. to make repairs to same
- (h) Methods of testing system for open wires, short circuit, ground
- (i) Regulations regarding both systems

2. Connecting cable to either system

- (a) Types, sizes and use of cable open wiring connectors
- (b) Methods of testing old installation for correct color coding e.g. Black - live circuit wire, White - neutral wire
- (c) Methods of connecting cable to system either exposed or concealed
- (d) Methods of connecting knob and tube system to surface or flush boxes or fittings

3. Extending circuit from either system

- (a) Types and sizes of porcelain fuse cutouts
- (b) Methods of connecting a cable to a surface cutout
- (c) Methods of connecting cutout to circuit feeders
- (d) Construction and use of loom duct
- (e) Types, sizes and current carrying capacity of wire used
- (f) Methods of providing mechanical protection and support of conductors

AN ANALYSIS OF THE ELECTRICAL TRADE (CONSTRUCTION)

ROUGHING-IN PROCEDURES

BLOCK 4: Wire and Cable

UNIT 2: Extra Low Voltage Wiring

OPERATIONS	KNOWLEDGE
<hr/>	
1. Installing extra low voltage wiring	<ul style="list-style-type: none">(a) Types and sizes of wire and cable(b) Methods of running, fishing, strapping, protecting bell wire and thermostat cable(c) General knowledge of extra low voltage auxiliary equipment to select proper wire or cable(d) Circuit protection(e) Sources of extra low voltage potentials(f) Types and sizes of tacks and staples(g) Ability to analyze circuits and read circuit diagrams(h) Mathematics to determine proper wire sizes; circular mils; series and parallel circuits(i) Knowledge of circuitry of remote control relays and switches(j) Methods of roughing-in relays and switch wires for a remote control system(k) Range of extra low voltage

AN ANALYSIS OF THE ELECTRICAL TRADE (CONSTRUCTION)

ROUGHING-IN PROCEDURES

BLOCK 4: Wire and Cable

UNIT 3: Non-metallic Sheathed Cable

OPERATIONS

KNOWLEDGE

- | | |
|--|--|
| 1. Cutting, running and securing non-metallic sheathed cable | <ul style="list-style-type: none">(a) Use and construction of non-metallic sheathed cable(b) Methods of handling coiled cable(c) Types and use of cable straps and connectors(d) Methods of skinning, strapping and protecting cable(e) Methods of fishing cable(f) Number of outlets permitted per circuit(g) Deciding location of branch circuit panel before running circuit feeders(h) Quality of workmanship |
| 2. Connecting and insulating joints in boxes | <ul style="list-style-type: none">(a) Making, soldering and insulating a 'pig tail' splice(b) Knowledge of wiring circuits to decide which wires to connect(c) Dielectric strength and insulators(d) Use and need for grounding conductor |
| 3. Checking and preparing work for covering-up inspection | <ul style="list-style-type: none">(a) Methods of protecting for prevention of injury by plasterers(b) Methods of protecting cable from driven nails(c) Methods of preparing work for continuity test by inspector |

AN ANALYSIS OF THE ELECTRICAL TRADE (CONSTRUCTION)

ROUGHING-IN PROCEDURES

BLOCK 4: Wire and Cable

UNIT 4: Armoured Cable

OPERATIONS	KNOWLEDGE
<hr/>	
1. Cutting and skinning armoured cable	(a) Types, sizes and use of armoured cable (b) Construction of armoured cable (c) Methods of cutting and skinning cable
2. Pulling-in and strapping armoured cable	(a) Minimum bending radius of cable (b) Sizes of holes required (c) Types and sizes of clips and straps (d) Methods of pulling-in, tightening and strapping cable
3. Connecting armoured cable to boxes	(a) Types, sizes and use of B.X. connectors (b) Bonding and grounding (c) Methods of connecting cable to boxes (d) Use of anti-short bushing

AN ANALYSIS OF THE ELECTRICAL TRADE (CONSTRUCTION)

ROUGHING-IN PROCEDURES

BLOCK 4: Wire and Cable

UNIT 5: Underground Cable

OPERATIONS

KNOWLEDGE

- | | |
|---|--|
| 1. Placing cable in trench | (a) Reading plans to determine trench width, depth, location and other details
(b) Frost level of local area
(c) Methods of drainage
(d) Types, sizes and current carrying capacity of underground cables
(e) Methods of handling coils and reels of cable
(f) Methods of pulling cable into trench |
| 2. Installing cable in underground box, manhole, fitting, etc. | (a) Methods of securing cable to box or fitting and skinning methods
(b) Types and use of waterproof box connectors, sealing compound, glands, fittings, etc.
(c) Use of firepot, torch for heating sealing compounds |
| 3. Terminating underground cable in above-ground box, panel or standard | (a) Methods of protecting cable when entering concrete base
(b) Types and use of protective paints
(c) Methods of painting pipes, boxes and fittings as an added protection from corrosion
(d) Science: Corrosion |
| 4. Completing underground cable installation | (a) Reading specifications to determine types of trench fill
(b) Methods of protecting cable when filling trench |

AN ANALYSIS OF THE ELECTRICAL TRADE (CONSTRUCTION)

ROUGHING-IN PROCEDURES

BLOCK 4: Wire and Cable

UNIT 6: Cab Tire Cable

OPERATIONS	KNOWLEDGE
<hr/>	
1. Cutting and skinning cab tire cable	(a) Types and sizes of cab tire cable (b) Methods of cutting and skinning cab tire cable with pliers, knife and strippers
2. Splicing and insulating cab tire cable	(a) Methods of making and insulating cable splices in boxes (b) Types and use of solderless connectors (c) Types and use of insulation
3. Connecting cab tire cable to boxes and fittings, etc.	(a) Method of making Underwriters knot (b) Types and use of box connectors for cab tire cable (c) Methods of connecting cab tire cable to boxes and fittings

AN ANALYSIS OF THE ELECTRICAL TRADE (CONSTRUCTION)

ROUGHING-IN PROCEDURES

BLOCK 4: Wire and Cable

UNIT 7: Miscellaneous Operations

OPERATIONS

KNOWLEDGE

1. Pulling in rubber covered wire

- (a) Types, sizes and current carrying capacity of rubber covered wire e.g. Type "R", Type "RH", and Type "RW"
- (b) Methods of pulling in rubber covered wire in raceways
- (c) Use of powdered soap stone, french chalk, liquid soap or other specified lubricant
- (d) Methods of coding wires for easy identification
- (e) Use of fish tape, rope, etc. for pulling in wires
- (f) Use of mechanical pulling devices e.g. block and tackle, chain falls, comealong and power winch
- (g) Circuits in relation to required wattage
- (h) Joule's Law to determine wire sizes

2. Pulling-in thermoplastic wire

- (a) Types, sizes and current carrying capacity of thermoplastic wire
- (b) Use of grease, vaseline and liquid soap or other specified lubricant
- (c) Types recommended for underground use

3. Pulling-in asbestos wire and fixture wire

- (a) Types, sizes and current carrying capacity of heat-resistant wire

4. Installing mineral insulated and aluminum sheathed cable

- (a) Types and sizes available
- (b) Types and sizes of connectors
- (c) Methods of installation
- (d) Advantages and disadvantages of use
- (e) Methods of bending
- (f) Methods of strapping
- (g) Special applications

AN ANALYSIS OF THE ELECTRICAL TRADE (CONSTRUCTION)

ROUGHING-IN PROCEDURES

BLOCK 5: Raceways

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AN ANALYSIS OF THE ELECTRICAL TRADE (CONSTRUCTION)

ROUGHING-IN PROCEDURES

BLOCK 5: Raceways

UNIT 1: Electrical Metallic Tubing

OPERATIONS

KNOWLEDGE

1. Cutting and reaming

- (a) Use and care of hacksaw and tubing cutter
- (b) Method of cutting and reaming E.M.T.
- (c) Construction and trade use of E.M.T.

2. Bending and shaping

- (a) Radii of bends permissible
- (b) Permissible number of 90° bends or the equivalent between boxes or fittings
- (c) Use of hickey or machine to bend the following: offset, kick (less than 90°), 90° bend to measurement, back to back 90° bend, saddle

3. Installing

- (a) Types and use of E.M.T. straps, couplings and connectors
- (b) Methods of installing E.M.T. concealed or exposed
- (c) Permissible installation locations
- (d) Number of wires relative to tubing size

AN ANALYSIS OF THE ELECTRICAL TRADE (CONSTRUCTION)

ROUGHING-IN PROCEDURES

BLOCK 5: Raceways

UNIT 2: Rigid Conduit

OPERATIONS	KNOWLEDGE
<hr/>	
1. Cutting and reaming rigid conduit	(a) Details of types and construction of conduit available: Galvanized, black enamel, special process type (b) Number of wires relative to conduit size (c) Methods of cutting and reaming conduit by hand or machine
2. Threading rigid conduit	(a) Types and sizes of stocks and dies (b) Methods of threading by hand or machine (c) Types and use of cutting oils
3. Bending and shaping rigid conduit	(a) Minimum radii of bends (b) Methods of bending (c) Types of bending equipment
4. Installing rigid conduit in surface locations: on wood, steel, masonry, concrete	(a) Types and use of: couplings, locknuts and bushings, racks and brackets, expansion joints, conduit fittings, boxes and fastening devices (b) Methods of installation (c) Methods of bonding and grounding
5. Installing rigid conduit prior to concreting and building-in	(a) Installation methods peculiar to concrete forms and masonry (b) Types and use of bushings and "pennies" to seal runs (c) Maximum vertical runs permitted
6. Installing rigid conduit underground and/or in wet locations	(a) Installation methods peculiar to underground conduit runs: Making watertight, grading to drain, painting, covering with back fill, special wrappings, encasing in cement

AN ANALYSIS OF THE ELECTRICAL TRADE (CONSTRUCTION)

ROUGHING-IN PROCEDURES

BLOCK 5: Raceways

UNIT 3: Flexible Conduit

OPERATIONS

KNOWLEDGE

- | | |
|---|---|
| 1. Cutting and reaming flexible conduit | (a) Details and construction of types and sizes available
(b) Methods of cutting and reaming
(c) Number of wires relative to conduit size
(d) Types, sizes and use of fittings available: Couplings and connectors |
| 2. Installing in exposed location | (a) Permissible uses and locations
(b) Methods of fitting and supporting
(c) Reason for use of liquid-tight flexible metal conduit and grounding |
| 3. Installing in concealed location | (a) Methods of fishing flexible conduit in concealed spaces |

AN ANALYSIS OF THE ELECTRICAL TRADE (CONSTRUCTION)

ROUGHING-IN PROCEDURES

BLOCK 5: Raceways

UNIT 4: Surface Metal Raceways

OPERATIONS	KNOWLEDGE
<hr/>	
1. Installing surface metal raceways in a finished building	(a) Details of types and sizes available (b) Types, sizes and use of boxes, fittings and adapters available (c) Number wires relative to raceway size (d) Installation methods regarding: Cutting and reaming, bending, fastening and supporting, extending from other wiring methods (e) Permissible locations

AN ANALYSIS OF THE ELECTRICAL TRADE (CONSTRUCTION)

ROUGHING-IN PROCEDURES

BLOCK 5: Raceways

UNIT 5: Underfloor Raceways

OPERATIONS

KNOWLEDGE

1. Installing underfloor raceway in a new building

- (a) Details of types and sizes available: Fiberduct, Q-Floor
- (b) Types, sizes and use of boxes, fittings and adapters available: Junction boxes, couplings, elbows, sleeves and brackets
- (c) Blueprint reading to determine: Layout of Header and junction unit with respect to cells for telephone, power inter-communication, signal systems
- (d) Installation methods regarding: Cutting, levelling, securing and adapting
- (e) Methods of locating, cutting and securing an outlet to an existing system

AN ANALYSIS OF THE ELECTRICAL TRADE (CONSTRUCTION)

ROUGHING-IN PROCEDURES

BLOCK 5: Raceways

UNIT 6: Duct Systems

OPERATIONS

KNOWLEDGE

1. Installing enclosed metal raceway for wires and cables or bus bars

- (a) Types, sizes and use of boxes, fittings and adapters
- (b) Blueprint reading to determine: runs, fittings, feeders, branches and controls
- (c) Installation methods

AN ANALYSIS OF THE ELECTRICAL TRADE (CONSTRUCTION)

SERVICES AND DISTRIBUTION

BLOCK 6: Service Entrance

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3: Pulling-in or installing cable	
4: Attaching pothead to cable	

AN ANALYSIS OF THE ELECTRICAL TRADE (CONSTRUCTION)

SERVICES AND DISTRIBUTION

BLOCK 6: Service Entrance

UNIT 1: Miscellaneous Operations

OPERATIONS	KNOWLEDGE
<hr/>	
1. Drilling wall for service conduit	<ul style="list-style-type: none">(a) Blueprint reading to determine location of service panel and point of conduit entrance(b) Consulting power authority and/or inspection department for details e.g. pole location, heights, special requirements and service location(c) Types and sizes of concrete drills or bits(d) Methods of drilling holes in concrete or other types of wall materials(e) Care in preventing excessive break-out(f) Importance of locating and aligning hole
2. Finishing around conduit	<ul style="list-style-type: none">(a) Proportion and ingredients used in neat cement(b) Types of ready-mix cement(c) Tools used in applying cement(d) Miscellaneous water proofing compounds
3. Mounting cabinet to hold service entrance equipment	<ul style="list-style-type: none">(a) Blueprint reading to determine specifications of cabinet

AN ANALYSIS OF THE ELECTRICAL TRADE (CONSTRUCTION)

SERVICES AND DISTRIBUTION

BLOCK 6: Service Entrance

UNIT 2: Entrance Stack or Conduit

OPERATIONS	KNOWLEDGE
<hr/>	
1. Cutting conduit for stack	(a) Considerations in determining size, length, height and location of stack (b) Methods of cutting conduit (c) Materials used in conduit (d) Types of conduit (e) Standard sizes and lengths of conduit (f) Need for reaming conduit
2. Threading conduit	(a) Types of hand and power threading equipment (b) Type of thread used (c) Types of cutting compounds
3. Mounting weatherheads	(a) Types and sizes of weatherheads (b) Materials used in weatherhead insulators (c) Need for weatherhead
4. Mounting outside meter socket and/or meter box	(a) Sizes of meter sockets and boxes (b) Construction and circuitry of meter socket (c) Recommended reading height
5. Assembling stack	(a) Types and sizes of locknuts and bushings (b) Common types and sizes of condulets (c) Methods of water proofing condulets, etc. (d) Providing for condensation
6. Mounting stack	(a) Methods of securing stack to different types of walls (b) Types of wall anchors, clips, or straps (c) Types of "mast" stacks for bungalows with less than 9 foot eave clearance (d) Methods of mounting and anchoring masts
7. Mounting racks	(a) Types of secondary racks (b) Methods of mounting racks

AN ANALYSIS OF THE ELECTRICAL TRADE (CONSTRUCTION)

SERVICES AND DISTRIBUTION

BLOCK 6: Service Entrance

UNIT 3: Underground Entrance

OPERATIONS	KNOWLEDGE
<hr/>	
1. Digging trench for underground cable	(a) Blueprint reading to determine location and depth of trench (b) Types of hand and power digging tools (c) Types of local soil and strata
2. Installing duct for cable	(a) Blueprint reading to determine length, diameter and type of duct used (b) Various types of ducts (c) Types of duct couplings (d) Types of water proof sealing compounds (e) Provision for drainage
3. Laying-in cable	(a) Blueprint reading to determine length, size and type of cable used (b) Types of cables used (c) Current and voltage ratings (d) Methods of pulling-in cable (e) Methods of anchoring duct or cable to pole (f) Methods of sealing between cable and duct (g) Other types of cable protection

AN ANALYSIS OF THE ELECTRICAL TRADE (CONSTRUCTION)

SERVICES AND DISTRIBUTION

BLOCK 7: Service Panel

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2: Preparing for installation of meters	
3: Mounting recording-type meters	
4: Mounting indicating demand-meters	
5: Mounting panel voltmeters	
6: Mounting potential transformers	
7: Mounting panel ammeters	
8: Mounting current transformers	
9: Wiring panel meters	

AN ANALYSIS OF THE ELECTRICAL TRADE (CONSTRUCTION)

SERVICES AND DISTRIBUTION

BLOCK 7: Service Panel

UNIT 1: Main Distribution

OPERATIONS

KNOWLEDGE

1. Cutting panel to receive
stack conduit or entrance

- (a) Methods of determining location of panel opening for stack or cable
- (b) Tools and methods of cutting various panel materials

2. Mounting main disconnect
switch

- (a) Blueprint reading to determine current and voltage rating of switch, etc.
- (b) Calculations to determine size of main switch fuses, wire, conduit, and terminals
- (c) Sizes and placement of knockouts for back or side reception of conduit
- (d) Methods of mounting switch box, splitter box and trough on panel
- (e) Use of locknuts and bushings to secure conduit to switch box
- (f) Current and voltage ratings
- (g) Circuitry of main disconnect (phases)
- (h) Types of main fuses, breakers, splitter blocks or bars
- (i) Science: Kirchoff law of current

3. Grounding the system

- (a) Types of grounding terminals on main disconnects or combination panels
- (b) Size of grounding wires needed and insulation regulations
- (c) Types of grounding clamps
- (d) Need for grounding and sequence of connection
- (e) Maximum allowable resistance to earth
- (f) Methods of protecting ground conductors

AN ANALYSIS OF THE ELECTRICAL TRADE (CONSTRUCTION)

SERVICES AND DISTRIBUTION

BLOCK 7: Service Panel

UNIT 2: Sub-distribution

OPERATIONS	KNOWLEDGE
<hr/>	
1. Mounting distribution panels	<ul style="list-style-type: none">(a) Blueprint reading or calculations to determine size and number of circuits(b) Methods of mounting(c) Positioning panels so conduit will be level or plumb(d) Types and construction of distribution panels (fuse or breaker)(e) Circuitry and various systems(f) Current ratings of plug fuses(g) Types of combination panels (main disconnect and distribution), including lighting and range(h) Necessity of grounding system
2. Installing breakers	<ul style="list-style-type: none">(a) Types and sizes of circuit breakers(b) Methods of installing breakers in panel(c) Operation and circuitry of magnetic breakers(d) Operation and circuitry of thermal breakers(e) Current and voltage ratings(f) Methods of ganging single breakers(g) Importance of balancing circuit loads

AN ANALYSIS OF THE ELECTRICAL TRADE (CONSTRUCTION)

SERVICES AND DISTRIBUTION

BLOCK 7: Service Panel

UNIT 3: Metering

OPERATIONS

KNOWLEDGE

- | | |
|---|---|
| 1. Installing condulets | (a) Types of condulets for meter leads (C & E)
(b) Types of conduit covers |
| 2. Preparing for installation of meters | (a) Methods of mounting and need for adequate space
(b) Types of single phase meters
(c) Types of polyphase meters
(d) Operation and circuitry of KWH meters
(e) Voltage and current ratings |
| 3. Mounting recording-type meters | (a) Methods of mounting
(b) Current, voltage or wattage ratings
(c) Electrical circuit of instrument
(d) Methods of chart timing
(e) Rate-gear units for chart speeds
(f) Methods of feeding ink to pen |
| 4. Mounting indicating demand-meters | (a) Methods of mounting
(b) Voltage and current ratings
(c) Circuitry of meter
(d) Reasons for using demand meter |
| 5. Mounting panel voltmeters | (a) Sizes of panel voltmeters
(b) Methods of mounting |
| 6. Mounting potential transformers | (a) Methods of mounting
(b) Theory of potential transformers
(c) Need for transformers in high voltage metering
(d) Science: (i) Characteristics and principles of transformers
(ii) Construction and operation |
| 7. Mounting panel ammeters | (a) Sizes and types of panel ammeters
(b) Methods of mounting
(c) Current ratings |

AN ANALYSIS OF THE ELECTRICAL TRADE (CONSTRUCTION)

SERVICES AND DISTRIBUTION

BLOCK 7: Service Panel

UNIT 3: Metering

OPERATIONS	KNOWLEDGE
8. Mounting current transformers	(a) Methods of mounting (b) Need for current transformers in high current metering (c) Safety: Danger of unloaded secondary of current transformers
9. Wiring panel meters	(a) Types of wires and bus-bars used in panel wiring (b) Types of insulators and bus mountings used in panel wiring

AN ANALYSIS OF THE ELECTRICAL TRADE (CONSTRUCTION)

SERVICES AND DISTRIBUTION

BLOCK 8: Transformer Services

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AN ANALYSIS OF THE ELECTRICAL TRADE (CONSTRUCTION)

SERVICES AND DISTRIBUTION

BLOCK 8: Transformer Services

UNIT 1: Indoor Installations

OPERATIONS

KNOWLEDGE

- | | |
|---|---|
| 1. Connecting oil-filled transformers | <ul style="list-style-type: none">(a) Purpose and details of vault(b) Permissible installations without a vault(c) Need for metal or concrete pan to retain liquid of largest transformer(d) Methods of mounting transformer on floor or wall(e) Blue print reading to determine voltage and KVA rating(f) Need and methods of draining and ventilating vault(g) Need of keeping out unauthorized persons(h) Methods of cooling(i) Methods of connecting relative to: HT, LT and polarity |
| 2. Installing dry-core open-ventilated transformers | <ul style="list-style-type: none">(a) Placement spacing in respect to combustible walls, etc.(b) Need for grounded non-combustible metal sheets when combustible materials are present(c) Protection from metal dust(d) Methods of making transformers explosion proof(e) Ventilation requirements |
| 3. Connecting cables to transformer secondaries | <ul style="list-style-type: none">(a) Types of cable lugs and connectors(b) Methods of supporting cables |
| 4. Installing bus-bars and risers | <ul style="list-style-type: none">(a) Blueprint reading to determine size location of bus-bars(b) Methods of mounting bus-bars(c) Types of bus-bar clamps and connectors(d) Protection or guards for bare bus-bars(e) Hazardous locations(f) What constitutes a "workmanlike installation" |

AN ANALYSIS OF THE ELECTRICAL TRADE (CONSTRUCTION)

SERVICES AND DISTRIBUTION

BLOCK 8: Transformer Services

UNIT 1: Indoor Installations

OPERATIONS	KNOWLEDGE
<hr/>	
5. Connecting transformers as a bank	(a) Blueprint reading to determine sizes and type of conductors or bus-bars (b) Methods of supporting bus-bars (c) Mathematics: (i) Sine curves; maximum, average and effective values (ii) Inductive and capacitive reactance, impedance (iii) Resonance, true and reactive power, power factor, vectors (d) Science: Star, delta and open delta connections - (i) Voltage and current ratios (ii) Methods of 'phasing out' (iii) Transformer action, construction and loading
6. Installing high potential circuit breakers	(a) Blueprint reading to determine location of breakers (b) Construction of circuit breakers (c) Methods of indicating open or closed (d) Remote control operation (e) Methods of mounting breakers (f) Operation and circuitry of breaker trip coil (g) Methods of group-operating (h) Methods of interlocking

AN ANALYSIS OF THE ELECTRICAL TRADE (CONSTRUCTION)

FINISHING TECHNIQUES

BLOCK 9: Wiring Devices

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11: Installing thru-cord switch	
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2: Installing bells and door chimes	

AN ANALYSIS OF THE ELECTRICAL TRADE (CONSTRUCTION)

FINISHING TECHNIQUES

BLOCK 9: Wiring Devices

UNIT 1: Switches and Push-Buttons

OPERATIONS	KNOWLEDGE
<hr/>	
1. Preparing box for switch or receptacle	(a) Use of tap to clean out screw holes (b) Tap and screw sizes (c) Desirability of using paper fill or blank cover to prevent plaster or other material from entering box
2. Installing S.P.S.T. flush switches in box	(a) Types and construction of push-button, tumbler or key-operated flush switches (b) Materials used in switches (c) Amperage and voltage ratings (d) Methods of securing conductors to switches (e) Screw sizes used (f) Uses of single pole switches (g) Reason for plumbing a switch (h) Correct spacing of switches to take a ganged cover
3. Installing S.P.D.T. and D.P.D.T. switches in box	(a) Need and application of three-way and four-way switches (b) Circuitry of switch and associated wiring
4. Installing flush tumbler silent switch in box	(a) Advantages of mercury and other silent switches (b) Importance of correct positioning
5. Mounting surfex switch	(a) Types and construction of plastic and porcelain surfex type switches (b) Methods of mounting (c) Methods of connecting conductors to switch (d) Advantages and disadvantages of surfex type installations
6. Installing pony type surface mounted switch	(a) Types of surface mounted tumbler and rotary switches (b) Methods of mounting (c) Applications of surface mounted switches

AN ANALYSIS OF THE ELECTRICAL TRADE (CONSTRUCTION)

FINISHING TECHNIQUES

BLOCK 9: Wiring Devices

UNIT 1: Switches and Push-Buttons

OPERATIONS

KNOWLEDGE

- | | |
|--|---|
| 7. Installing flush rotary multi-position switch in box | (a) Series-parallel circuitry of multi-position switches
(b) Applications of multi-position switches
(c) Size of box required for switch |
| 8. Installing surface rotary heater switch | (a) Construction and circuitry of multi-heat rotary switches
(b) Methods of mounting
(c) Applications of multi-heat switches
(d) Voltage and current ratings |
| 9. Installing door switch | (a) Various sizes of door switches
(b) Applications of door switches
(c) Methods of mounting
(d) Size of plate and hole required for door switch |
| 10. Installing rotary canopy or levolier pull chain switch | (a) Circuitry and construction of switch
(b) Method of mounting
(c) Applications of switch |
| 11. Installing thru-cord switch | (a) Construction and circuitry of thru-cord switches
(b) Applications of switch
(c) Methods of connecting two and three wire cords to switch |
| 12. Mounting push buttons | (a) Types and construction of push buttons
(b) Methods of mounting
(c) Applications of push buttons |

AN ANALYSIS OF THE ELECTRICAL TRADE (CONSTRUCTION)

FINISHING TECHNIQUES

BLOCK 9: Wiring Devices

UNIT 2: Receptacles

OPERATIONS

KNOWLEDGE

- | | |
|---------------------------------------|---|
| 1. Mounting flush receptacle in a box | (a) Sizes and types of flush receptacles
(b) Construction and materials of receptacles
(c) Amperage and voltage ratings
(d) Use and reason for grounding terminals
(e) Use and types of polarized receptacles |
| 2. Mounting surface receptacles | (a) Types and kinds of surface mounted receptacles
(b) Methods of mounting |
| 3. Mounting weatherproof receptacles | (a) Types and construction of weatherproof receptacles
(b) Methods of mounting
(c) Methods of weatherproofing |
| 4. Mounting miscellaneous receptacles | (a) Types of receptacles - clock hanger - radio outlet - multiple miniature combinations
(b) Use of cube and triple taps |
| 5. Mounting pilot light receptacles | (a) Construction and circuitry of pilot light receptacle
(b) Methods of mounting
(c) Types and sizes of pilot light bulbs
(d) Wattage ratings of bulbs
(e) Reasons for using pilot or indicator lights |

AN ANALYSIS OF THE ELECTRICAL TRADE (CONSTRUCTION)

FINISHING TECHNIQUES

BLOCK 9: Wiring Devices

UNIT 3: Plates and Covers

OPERATIONS

KNOWLEDGE

1. Mounting plain covers

- (a) Materials used in covers
- (b) Sizes and types of covers for condulets, octagon, and other devices, and fittings
- (c) Size and types of screws used
- (d) Methods of weather proofing covers on outside condulets and boxes

2. Mounting switch plates and receptacle covers

- (a) Types of single and ganged switch plates
- (b) Types of single and ganged receptacle covers
- (c) Types of switch, receptacle and pilot light combination covers
- (d) Use of jewels and reflectors
- (e) Methods of mounting

AN ANALYSIS OF THE ELECTRICAL TRADE (CONSTRUCTION)

FINISHING TECHNIQUES

BLOCK 9: Wiring Devices

UNIT 4: Signalling Devices

OPERATIONS

KNOWLEDGE

1. Installing buzzers

- (a) Circuitry and construction of buzzer
- (b) Types of buzzers
- (c) Methods of mounting
- (d) Voltage ratings and sizes
- (e) Methods of adjusting

2. Installing bells and door chimes

- (a) Circuitry and construction of single stroke and vibrating bells and chimes
- (b) Types of signalling and alarm bells
- (c) Methods of mounting
- (d) Combination buzzer-bells and front and back door chimes
- (e) Voltage ratings and sizes
- (f) Specifications of low voltage transformers

FINISHING TECHNIQUES

BLOCK 10: Lighting

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AN ANALYSIS OF THE ELECTRICAL TRADE (CONSTRUCTION)

FINISHING TECHNIQUES

BLOCK 10: Lighting

UNIT 1: Caps, Extension Cords, and Lampholders

OPERATIONS

KNOWLEDGE

- | | |
|---|---|
| 1. Removing insulation from extension cords | (a) Types of cord insulation and coverings
(b) Types and size of conductors used in extension cords
(c) Tools used to remove insulation
(d) Methods of removing insulation safely
(e) Methods of obtaining flexibility
(f) Voltage and current ratings |
| 2. Attaching cords to caps | (a) Types and kinds of caps
(b) Materials used in caps
(c) Methods of securing conductors to cap pins
(d) Methods of gripping cords |
| 3. Tying an Underwriters knot | (a) How to tie an Underwriters knot
(b) Where an Underwriters knot may be used |
| 4. Attaching cords to lampholders | (a) Materials used in lampholders
(b) Types and construction of keyless lampholders
(c) Types of keyed lampholders
(d) Use and need for insulated bushings
(e) Methods of switching
(f) Sizes of lampholders
(g) Voltage and current ratings
(h) Types of guards used on extension lamps
(i) Circuitry of trilight lamps
(j) Wattage of trilight lamps and bases |
| 5. Mounting lampholders | (a) Methods of mounting lampholders on table and floor lamps |
| 6. Extending extension cords | (a) Types of cord connectors and connector bodies
(b) Types and kinds of adaptors and attachments |

AN ANALYSIS OF THE ELECTRICAL TRADE (CONSTRUCTION)

FINISHING TECHNIQUES

BLOCK 10: Lighting

UNIT 2: Incandescent Lighting

OPERATIONS	KNOWLEDGE
<hr/>	
1. Mounting fixture bar on box	(a) Types of fixture bars (b) Need for fixture bars (c) Safety: Use of approved ladders and scaffolding
2. Connecting fixture leads to line wires	(a) Types of leads used in light fixtures (b) Methods of connecting (c) Types of connectors
3. Mounting common fixture to bar or box	(a) Types of keyed and keyless fixture lampholders (b) Types of angle and swivelier lampholders (c) Methods of switching (d) Methods of mounting (e) Miscellaneous types of lampholders and fixtures (canopy, surface, sign, surfex, etc.) (f) Current and voltage ratings
4. Inserting light bulbs	(a) Sizes, types and bases (b) Materials used in bulbs (c) Voltage and wattage ratings (d) Methods of measuring light intensity
5. Hanging lampshades or globes	(a) Materials used in lampshades (b) Methods of hanging or attaching lampshades or globes to fixture
6. Attaching globes to vapor-tight fittings	(a) Sizes and types of globes (b) Method of making vapor-tight
7. Attaching guards	(a) Sizes and types of guards (b) Application and need for guards

AN ANALYSIS OF THE ELECTRICAL TRADE (CONSTRUCTION)

FINISHING TECHNIQUES

BLOCK 10: Lighting

UNIT 2: Incandescent Lighting

OPERATIONS

KNOWLEDGE

- | | |
|---------------------------------------|---|
| 8. Mounting weatherproof fixtures | (a) Types of weatherproof fixtures
(b) Construction of weatherproof fittings
(c) Methods of mounting
(d) Methods of weatherproofing |
| 9. Mounting reflectors | (a) Sizes and types of reflectors
(b) Methods of mounting |
| 10. Mounting explosion-proof fixtures | (a) Construction of these fixtures
(b) Methods of protecting against mechanical injury
(c) Use of flexible connectors for suspending
(d) Use of approved seals and sealing compounds |
| 11. Installing recessed fixtures | (a) Methods of fire-proofing
(b) Methods of ventilating |

AN ANALYSIS OF THE ELECTRICAL TRADE (CONSTRUCTION)

FINISHING TECHNIQUES

BLOCK 10: Lighting

UNIT 3: Recessed Fluorescent Fixtures

OPERATIONS	KNOWLEDGE
<hr/>	
1. Dismantling commercial fixture prior to installation	(a) Names of component parts of fixtures (b) Methods of assembly and construction features
2. Mounting channel bridge	(a) Blueprint reading to determine location of fixture(s) and type (b) Types of channel bridges for recessed fixtures (c) Methods of securing bridge to ceiling joists (d) Types of bridge supports needed for incorrect joist spacing
3. Securing troffer or main chassis	(a) Methods of securing troffer to bridge (b) Methods of adjusting troffer for correct depth (c) Methods of securing sides of troffer to joists or bridge supports
4. Mounting trim strip	(a) Types of trim strips for different ceiling finishes (b) Methods of mounting trim strips (c) Use of trim strips to support troffers in some fixtures
5. Connecting fixture leads to line wires	(a) Types of connectors (b) Science: Circuitry of fluorescent fixtures and use of ballasts, chokes, capacitors
6. Attaching reflector to support	(a) Methods of suspending reflector from cover (on some fixtures) for easy mounting of troffer or cover, and connecting wiring, etc. (b) Methods of attaching reflector to reflector support

FINISHING TECHNIQUES

BLOCK 10: Lighting

UNIT 3: Recessed Fluorescent Fixtures

OPERATIONS	KNOWLEDGE
7. Inserting lamps in holders	(a) Types of lampholders and design to lock lamp in place (b) Sizes and types of lamps (c) E, I, and W ratings of lamps (d) Construction and materials used in lamps (e) Science - ionization of gases, conductivity, use and types of phosphorus, stroboscopic effect (f) Safety - Care in handling of lamps, and danger of phosphors
8. Inserting starters	(a) Science (i) Purpose and operation of starter (ii) Operation, circuitry and wattage of instant and rapid start

AN ANALYSIS OF THE ELECTRICAL TRADE (CONSTRUCTION)

FINISHING TECHNIQUES

BLOCK 10: Lighting

UNIT 4: Surface Mounted and Suspended
Fluorescent Fixtures

OPERATIONS	KNOWLEDGE
<hr/>	
1. Surface mounting individual fixtures	(a) Blueprint reading to determine location of fixture (b) Methods of mounting troffers or cover on various types of ceilings (toggle bolts, tampins, screws)
2. Mounting channel continuous rows	(a) Blueprint reading to determine location of channel and length required (b) Standard channel lengths (c) Methods of joining channels (d) Channel accessories
3. Installing suspended fixtures	(a) Methods of suspension (single stem, hanger, conduit, strap, chain, steel wire) (b) Methods of anchoring suspension device to ceiling (c) Methods of attaching suspension device to fixture or channel (d) Methods of attaching fixtures to channel (e) Advantages of using wiring channels

FINISHING TECHNIQUES

BLOCK 10: Lighting

UNIT 5: Miscellaneous Lighting Controls

OPERATIONS	KNOWLEDGE
1. Installing touch-plate switches in low voltage remote control systems	(a) Construction of the switch (b) Methods of mounting (c) Types of single and multiple switch combinations (d) Types of switch and pilot light combinations (e) Circuitry of master control panel and master visual indicator panels
2. Mounting relay units	(a) Function and operation of the relay (b) Types of multiple relay units (c) Position of relay when mounted (d) Circuitry of multiple relay units
3. Installing transformer or transverter	(a) Voltage rating of transformer (AC systems) (b) Circuitry and function of transverter (low DC system) (c) Methods of mounting transformers and transverters on or in various boxes
4. Installing light intensity control for small room	(a) Size of switch box required (b) Function and operation of auto-transformer (c) Circuitry of the control
5. Installing stacked dimmers for large room	(a) Blueprint reading to determine location of auto-transformers and control knob (b) Methods of stacking or ganging transformers (c) Wattage ratings of transformers (d) Methods of changing the transformer ratios (manual or motor controlled) (e) Miscellaneous types of dimmers

FINISHING TECHNIQUES

BLOCK 11: Testing and Measuring

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FINISHING TECHNIQUES

BLOCK 11: Testing and Measuring

UNIT 1: Continuity Testing

OPERATIONS	KNOWLEDGE
1. Testing continuity of circuit with bell-ringer	(a) Circuitry of bell ringer (b) Use of ringer to test continuity of wiring (c) Use of ringer to test for opens, grounds and shorts (d) Applications and limitations of bell ringer
2. Testing with bell or buzzer and battery	(a) Circuitry of bell or buzzer (b) Applications and limitations of bell or buzzer tester (c) Science: Types of cells
3. Testing with a test lamp	(a) Use of 110 volts and series test lamp to locate opens, grounds, and shorts (b) Applications and limitations of test lamp
4. Testing with an ohmmeter	(a) Types of ohmmeters (b) Use of ohmmeter (see Unit 2) (c) Safety - never use ohmmeter on live circuit (d) Limitations of ohmmeter
5. Testing with a voltmeter	(a) Use of voltmeter to check from point to point on a live circuit for continuity
6. Testing by using a low wattage lamp in the fuse panel to locate a short or a ground	(a) Sequence of checking circuit by the process of elimination (b) Necessity for using a low wattage lamp (c) Voltages of three-wire distribution system
7. Identifying wires using a set of sound-power telephones	(a) Circuitry of sound-power telephones (b) Operating principles of sound-power phones (c) Induction cross-talk and the danger of error (d) Methods of identifying wires e.g. marks, tags, stickers, etc.

FINISHING TECHNIQUES

BLOCK 11: Testing and Measuring

UNIT 2: Resistance Measuring

OPERATIONS	KNOWLEDGE
1. Measuring resistance with an ohmmeter	(a) Circuitry of ohmmeter (b) Methods of obtaining various ranges (c) Types of V.O.M.'s and V.T.V.M.'s (d) Types of test leads and probes (e) Use of each type of ohmmeter (f) Various meter scales (g) Science: Factors affecting resistance
2. Measuring resistance with a Wheatstone bridge	(a) Types of Wheatstone bridges (b) Circuitry of bridge (c) Methods of varying the bridge resistances (d) Mathematics to determine resistance by ratio and proportion (e) Use and applications of the bridge
3. Measuring resistance with a megger	(a) Use of megger for high resistance measuring (insulation resistance, earth resistance, etc.) (b) Circuitry of megger
4. Calculating resistance by voltmeter-ammeter method	(a) Types and principles of ammeters and voltmeters (b) Use of Ohm's Law (c) Science: (i) Ampere flow and conductivity (ii) Electro-motive force
5. Calculating resistance by drop in potential method	(a) Use of Voltmeter to measure voltage across known and unknown resistances in series

FINISHING TECHNIQUES

BLOCK 11: Testing and Measuring

UNIT 3: Voltage Measuring

OPERATIONS	KNOWLEDGE
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1. Connecting portable voltmeter to circuit	(a) Types of voltmeters (b) Circuitry of voltmeter (c) How to connect voltmeter (d) Observance of polarity in DC (e) Safety - Safe practices to observe in respect to high voltage, grounding, etc. (f) Types of test leads and probes (g) Voltage limits of meter (h) Ohms per volt rating of meters (i) Methods of increasing range
2. Measuring voltage with solenoid type voltage tester	(a) Types of solenoid testers (b) Circuitry and operation of tester (c) Voltage limits of tester (d) Use of neon bulb to indicate potential
3. Determining approximate voltage with neon tester	(a) Use of neon tester to determine hot wire when not color coded (b) Use of light intensity of bulb to indicate approximate voltage

AN ANALYSIS OF THE ELECTRICAL TRADE (CONSTRUCTION)

FINISHING TECHNIQUES

BLOCK 11: Testing and Measuring

UNIT 4: Current Measuring

OPERATIONS	KNOWLEDGE
<hr/>	
1. Measuring current with clamp-on type ammeter	(a) Types of clamp-on ammeters (b) Theory of operation of meter (c) How to use meter (d) Safety - How to use meter without personal harm (e) Current limits of meter (f) Advantages of clamp-on meters (g) Full scale deflection current ratings of ammeters
2. Measuring current with conventional type ammeter	(a) Types of ammeters (b) How to connect meter in the circuit (c) Methods of changing ammeter range (d) Theory of ammeter shunts

AN ANALYSIS OF THE ELECTRICAL TRADE (CONSTRUCTION)

AUXILIARY SYSTEMS AND EQUIPMENT

BLOCK 12: Furnace Controls

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NOTE: Gas burning equipment has not been included for two reasons, namely (a) gas is not available on a country-wide basis (b) in general, the installation of gas burning equipment presents no techniques not required or met with in dealing with other equipment

AN ANALYSIS OF THE ELECTRICAL TRADE (CONSTRUCTION)

AUXILIARY SYSTEMS AND EQUIPMENT

BLOCK 12: Furnace Controls

UNIT 1: Thermostats and Disconnect Switches

OPERATIONS	KNOWLEDGE
<hr/>	
1. Installing thermostat	(a) Operation of the thermostat (b) Efficient location of the thermostat (c) Methods of mounting thermostats
2. Wiring thermostat	(a) Types and function of thermostats (b) Tracing a circuit from Manufacturer's instruction sheet (c) Methods of low voltage wiring (d) Sources of low voltage (e) Colour coding wires and terminals
3. Setting and adjusting thermostats	(a) Sensitivity of thermostats (b) Thermostat differentials (c) "Change over" of Day - Night Controls (d) Science: Coefficient of expansion
4. Installing disconnect switch	(a) Location of the switch relative to burner (b) Horsepower rating of switches (c) Branch Circuit protection (d) Grounding of heating equipment
5. Installing fan switch	(a) Types and ratings of switches for motors (b) Methods of mounting switches (c) Fan circuitry for forced air equipment

AN ANALYSIS OF THE ELECTRICAL TRADE (CONSTRUCTION)

AUXILIARY SYSTEMS AND EQUIPMENT

BLOCK 12: Furnace Controls

UNIT 2: Protector Relay

OPERATIONS	KNOWLEDGE
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1. Installing a stack mounted relay	(a) Methods of mounting stack relays (b) Position of the stack relay in relation to draft regulators
2. Wiring stack controls	(a) Wire sizes, type of insulation and enclosure (b) Circuitry of installation instructions (c) Separation of wires of different voltages (d) Method of securing cables to stack controls (e) Constant ignition and timed ignition burners (f) Science: Electromagnetism and transformer action
3. Checking and adjusting stack mounted relays	(a) Ignition timing adjustments (b) Re-cycle timing (c) Timing of combustion contacts (d) Intermittent ignition
4. Wiring electronic protector relay	(a) Circuitry of installation instructions (b) High and low fire control (c) Function of electronic relay (d) Types of electronic relays
5. Matching line voltage to correct protector relay voltage	(a) Voltage distribution systems
6. Wiring the flame detector	(a) Moisture-proof and heat resistant wires (b) Types of flame detectors (c) Function of flame detector (d) Science: Principles of photo cells and thermo-couples

AN ANALYSIS OF THE ELECTRICAL TRADE (CONSTRUCTION)

AUXILIARY SYSTEMS AND EQUIPMENT

BLOCK 12: Furnace Controls

UNIT 3: Limit Controls

OPERATIONS	KNOWLEDGE
<hr/>	
1. Wiring an airstat	(a) Function of the airstat (b) Location of the airstat in the wiring circuit (c) Series circuits (d) Location of airstat in the plenum
2. Setting limit control and fan control	(a) High limit setting (b) Fan differentials
3. Wiring aquastat	(a) Types and operation of aquastats (b) Location of aquastats (c) Line and low voltage pump controls
4. Wiring pressuretrols	(a) Operation of Mercury bulbs (b) Mounting position of Mercury bulbs

AN ANALYSIS OF THE ELECTRICAL TRADE (CONSTRUCTION)

AUXILIARY SYSTEMS AND EQUIPMENT

BLOCK 12: Furnace Controls

UNIT 4: Oil Burner Wiring

OPERATIONS

KNOWLEDGE

- | | |
|----------------------------------|--|
| 1. Installing flexible conduit | (a) Vibration absorption of flexible conduit
(b) Methods of installing flexible conduit |
| 2. Wiring oil burners | (a) Requirements of constant ignition and intermittent ignition
(b) Voltage of ignition transformer
(c) Overload protection of motors
(d) Operation of electric oil valve |
| 3. Checking wiring of oil burner | (a) Methods of testing wiring
(b) Proper setting of limit controls if provided
(c) Methods of testing ignition |
| 4. Cleaning relay contacts | (a) Materials used for relay contacts
(b) Abrasives recommended for cleaning contacts |

AN ANALYSIS OF THE ELECTRICAL TRADE (CONSTRUCTION)

AUXILIARY SYSTEMS AND EQUIPMENT

BLOCK 12: Furnace Controls

UNIT 5: Coal Stoker Wiring

OPERATIONS

KNOWLEDGE

1. Wiring coal stoker

- (a) Operation of the coal stoker
- (b) Electrical controls used in coal stokers
- (c) Circuitry of limit controls and circulation controls
- (d) Automatic and manual operation of the coal stoker

2. Setting stoker control

- (a) Information re hold fire and firing periods from manufacturer's instruction manual

AN ANALYSIS OF THE ELECTRICAL TRADE (CONSTRUCTION)

AUXILIARY SYSTEMS AND EQUIPMENT

BLOCK 13: Rotating Equipment

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2: Reversing direction of rotation	
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AN ANALYSIS OF THE ELECTRICAL TRADE (CONSTRUCTION)

AUXILIARY SYSTEMS AND EQUIPMENT

BLOCK 13: Rotating Equipment

UNIT 1: Single Phase Motors

OPERATIONS	KNOWLEDGE
1. Mounting single phase motor	(a) Types of drives (b) Types of pulleys (c) Alignment of pulleys to belt (d) Belt tension
2. Wiring single phase motor	(a) Importance of matching motor and line frequency and voltage (b) Mathematics to determine sizes of branch circuit conductors (c) Built-in over-load protection: (i) Where required (ii) Where not required (d) Over-Current protection: (i) Location in circuit (ii) Size in relation to motors and motor conductors (iii) Relationship of rotor speed to line current (e) Advantages and disadvantages of various types of motors (f) Mathematics to convert name-plate temperatures, Centigrade to Fahrenheit (g) Science: Types and their characteristics
3. Connecting dual voltage motor	(a) Three wire distribution system (b) Voltages across motor coil windings connected in series and parallel (c) Coil phasing for magnetic polarity (d) Science: Magnetic theory of permanent and electro-magnets
4. Connecting single phase motor to three phase, four-wire system	(a) Three phase, four-wire distribution systems (b) Grouping of motors on three phase, four-wire system (c) Science: Single and polyphase system
5. Wiring explosion-proof motor	(a) Details of explosion-proof fittings (b) Explosion-proof controls

AN ANALYSIS OF THE ELECTRICAL TRADE (CONSTRUCTION)

AUXILIARY SYSTEMS AND EQUIPMENT

BLOCK 13: Rotating Equipment

UNIT 1: Single Phase Motors

OPERATIONS

KNOWLEDGE

6. Sealing conductor race-ways to explosion-proof motors

- (a) Sealing compounds
- (b) Types of sealing fittings

7. Reversing single phase motor

- (a) Relationship of starting winding and running winding in capacitor and induction motors
- (b) Brush settings in a repulsion motor
- (c) Relationship of armature and field currents to direction of rotation of a series motor
- (d) Function of the shading ring in a shaded pole motor
- (e) Science:
 - (i) Phase relationship of E and I
 - (ii) Inductive and capacitive reactance
 - (iii) Theory and characteristics of single phase motors

AN ANALYSIS OF THE ELECTRICAL TRADE (CONSTRUCTION)

AUXILIARY SYSTEMS AND EQUIPMENT

BLOCK 13: Rotating Equipment

UNIT 2: Three Phase Motors

OPERATIONS	KNOWLEDGE
1. Installing three-phase squirrel cage motor	(a) Horsepower rating of disconnect switches (b) Location of disconnect switch relative to motor (c) Relationship of conductor size and class of service (d) Maximum allowable percentage voltage drop (e) Mathematics to determine percentage line drop (f) Demand factor of conductors for grouping of motors
2. Reversing the direction of rotation	(a) Science: Operating principles of squirrel cage motors
3. Connecting line wires to motor leads	(a) Types and ratings of solderless lugs and connectors (b) Use of locknuts or lock washers with bolts for connecting terminals to line
4. Installing compression type lugs and connectors	(a) Tools for installing compression fittings
5. Sweating lugs on cables	(a) Function of solder fluxes (b) Types of solder fluxes for electrical work (c) Types and sizes of solder lugs (d) Preparation of lugs and cables for soldering (e) Importance of proper amount of heat (f) Protection of cable insulation adjacent to lugs
6. Insulating joints for high voltage motor	(a) Types of tapes (b) Insulation compounds (c) Moisture-proofing of joints

AN ANALYSIS OF THE ELECTRICAL TRADE (CONSTRUCTION)

AUXILIARY SYSTEMS AND EQUIPMENT

BLOCK 13: Rotating Equipment

UNIT 2: Three Phase Motors

OPERATIONS

KNOWLEDGE

- | | |
|--|--|
| 7. Installing wound rotor induction motor | <ul style="list-style-type: none">(a) Speed ranges and regulation(b) Speed vs. torque and line current(c) Primary and secondary currents(d) Rotor current and secondary conductors(e) Types and use of tachometer(f) Theory and operating characteristics |
| 8. Wiring three phase synchronous motor | <ul style="list-style-type: none">(a) Principle of operation(b) Interpreting schematic diagrams(c) Significance and methods of correcting power factor |
| 9. Wiring direct current exciter for synchronous motor | <ul style="list-style-type: none">(a) Checking DC polarity(b) Types of DC generators(c) Voltage control circuits |

AN ANALYSIS OF THE ELECTRICAL TRADE (CONSTRUCTION)

AUXILIARY SYSTEMS AND EQUIPMENT

BLOCK 13: Rotating Equipment

UNIT 3: Direct Current Generators

OPERATIONS	KNOWLEDGE
1. Installing direct current generator	(a) Principles of direct current generation
	(b) Excitation of magnetic fields: (i) Separately excited generators (ii) Self excited generators
	(c) Types of direct current generators: (i) Series wound (ii) Shunt wound (iii) Compound wound
	(d) Rotation of generator and the reference for checking direction
	(e) Voltage regulation of a direct current generator
2. Checking output	(a) Factors affecting voltage build-up (b) Load characteristics of DC generators

AN ANALYSIS OF THE ELECTRICAL TRADE (CONSTRUCTION)

AUXILIARY SYSTEMS AND EQUIPMENT

BLOCK 13: Rotating Equipment

UNIT 4: Direct Current Motors

OPERATIONS	KNOWLEDGE
<hr/>	
1. Installing direct current motor	(a) Principles of DC motors (b) Types of direct current motors: (i) Series wound (ii) Shunt wound (iii) Compound wound (c) Speed and running characteristics of the various types of direct current motors (d) Importance of direct coupling of series motor to load
2. Reversing direction of rotation	(a) Methods of reversing (b) Methods of checking direct current polarities (c) Methods of checking magnetic polarities

AN ANALYSIS OF THE ELECTRICAL TRADE (CONSTRUCTION)

AUXILIARY SYSTEMS AND EQUIPMENT

BLOCK 13: Rotating Equipment

UNIT 5: Inspection Procedures

OPERATIONS	KNOWLEDGE
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1. Checking motor bearings	(a) Types of bearings relative to motor application (b) Bearing lubrication (c) Causes of bearing wear
2. Checking noisy operation	(a) Effect of an open phase on a polyphase motor (b) Balance of rotor or balance of driven machine (c) Methods of testing for uniform air gap (d) Indications of loose parts
3. Checking slow starting	(a) Reasons for line drop (b) Unbalanced polyphase voltages (c) Effect of open or shorted capacitor on starting torque of a capacitor motor (d) Brush position and starting torque of repulsion motor (e) Brush tension and starting torque
4. Checking excessive brush sparking	(a) Correct brush tension (b) Effect of an open or short in the armature (c) Observations on the commutator (d) Effect of armature vibration and brush sparking (e) Common commutator troubles
5. Checking motor for non-starting	(a) Tests to be made for correct line voltage, frequency and phases (b) Starting switches and centrifugal mechanisms in single phase motors (c) Over-load tripping mechanism

AN ANALYSIS OF THE ELECTRICAL TRADE (CONSTRUCTION)

AUXILIARY SYSTEMS AND EQUIPMENT

BLOCK 14: Motor Control Equipment

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AN ANALYSIS OF THE ELECTRICAL TRADE (CONSTRUCTION)

AUXILIARY SYSTEMS AND EQUIPMENT

BLOCK 14: Motor Control Equipment UNIT 1: Manual Starting Switches

OPERATIONS	KNOWLEDGE
<hr/>	
1. Installing disconnect switch	(a) Types, sizes and horsepower ratings of switches (b) Location of disconnect switches relative to the motor (c) Simultaneous disconnecting of all line wires (d) Knowledge and significance of over-current protection (e) Sizes of fuses and starting current of the motor (f) Sizes of instant trip circuit breakers for over-current protection
2. Installing across-the-line starter	(a) Types and sizes of motor starting switches (b) Location of the motor starting switch in the circuit (c) Knowledge and significance of over-load protection (d) Factors governing requirements for over-load protection (e) Factors governing the maximum size of motors to be connected directly across-the-line
3. Installing heaters in starting switch	(a) Sizes and types of heaters (b) Calculating the size of heaters required for a motor (c) Function of the heaters (d) Correct positioning of the heaters relative to the bimetal mechanism (e) Function and operation of the bimetal unit

AN ANALYSIS OF THE ELECTRICAL TRADE (CONSTRUCTION)

AUXILIARY SYSTEMS AND EQUIPMENT

BLOCK 14: Motor Control Equipment UNIT 2: Magnetic Starting Switches

OPERATIONS

KNOWLEDGE

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| 1. Installing magnetic starting switch | (a) Types of magnetic starting switches
(b) Matching magnetic switch rating to the name plate data of the motor and to the line
(c) The importance of the correct voltage and frequency of magnetic coil |
| 2. Installing remote control push button station | (a) Use of normally "open" and normally "closed" contacts
(b) Tracing circuitry from the schematic diagram |
| 3. Connecting transformer for low-voltage control of high-voltage | (a) Step-down transformers
(b) Significance of "line side" and "load side" of motor-control circuits
(c) Relationship of the primary current to the secondary current in the transformer |
| 4. Wiring the push button to the magnetic starting switch | (a) Circuitry for the magnetic starting switch
(b) Use and reasons for arc shields
(c) Size of remote-control conductors |
| 5. Connecting two or more push buttons to control a magnetic starting switch | (a) Principles of series and parallel circuits
(b) Circuitry for multiple use of push buttons |
| 6. Installing start-jog-stop push button station | (a) Holding contact circuit
(b) Method of using a start button as a jog button |
| 7. Installing remote switch to control magnetic switch | (a) Types and sizes of remote control switches e.g. limit, float
(b) Circuitry to eliminate holding contacts |

AN ANALYSIS OF THE ELECTRICAL TRADE (CONSTRUCTION)

AUXILIARY SYSTEMS AND EQUIPMENT

BLOCK 14: Motor Control Equipment UNIT 3: Reversing Motor Switches

OPERATIONS	KNOWLEDGE
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1. Installing a manual reversing switch	(a) Size and types of drum controllers (b) Circuitry of drum controller
2. Installing a magnetic reversing switch	(a) Interpreting schematic diagram (b) Operation and function of mechanical and electrical interlocks

AN ANALYSIS OF THE ELECTRICAL TRADE (CONSTRUCTION)

AUXILIARY SYSTEMS AND EQUIPMENT

BLOCK 14: Motor Control Equipment

UNIT 4: Reduced Voltage Starters

OPERATIONS	KNOWLEDGE
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1. Installing manual reduced voltage motor starting switch	(a) Reasons for reduced voltage starters (b) Ratio of starting to running current (c) Regulations governing use of reduced-voltage starters (d) Types of reduced-voltage manual starters: (i) Primary resistance (ii) Auto transformer starters (e) Under-voltage and no-voltage protection (f) Circuitry of over-load relay (g) Auto-transformer connections (h) Operation of mechanical lockout
2. Installing automatic compensator	(a) Types of timers for automatic compensators (b) Methods of adjusting timer for automatic compensators (c) Interpretation of schematic diagrams

AN ANALYSIS OF THE ELECTRICAL TRADE (CONSTRUCTION)

AUXILIARY SYSTEMS AND EQUIPMENT

BLOCK 14: Motor Control Equipment UNIT 5: AC Speed Controllers

OPERATIONS	KNOWLEDGE
1. Installing variable resistance to vary the speed of a series motor	(a) Sizes and types of variable resistances (b) Relationship of motor current and speed of a series motor
2. Installing speed controller for wound rotor induction motor	(a) Meaning of primary and secondary currents in a wound rotor motor (b) Star connection of three-phase circuits (c) Relationship of secondary current and primary current
3. Installing speed controller and magnetic starting switch to a wound rotor motor	(a) Interlocking of control circuit in the primary and secondary control circuit
4. Installing two speed controller for a two winding squirrel cage motor	(a) Relationship of number of poles and the speed of the rotor (b) Electrical interlock circuit of "low" controller and "high" controller (c) Consequent pole connections
5. Installing AC quick stop controller	(a) Electric braking by plugging a motor (b) Circuitry of a plugging relay for motor braking

AN ANALYSIS OF THE ELECTRICAL TRADE (CONSTRUCTION)

AUXILIARY SYSTEMS AND EQUIPMENT

BLOCK 14: Motor Control Equipment UNIT 6: Direct Current Starters

OPERATIONS	KNOWLEDGE
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1. Installing three point starter	(a) Field current and holding coil circuit (b) Low voltage protection (c) Reason for no-field release
2. Installing four point starter	(a) Reason for and operation of no-voltage release (b) Advantage of four-point over three-point starter
3. Installing reversing drum controller	(a) Reasons for reversing the current in armature rather than field (b) Relationship of armature current and field current on rotation of series, shunt and compound motors
4. Installing magnetic switch control	(a) Necessity of cutting one line only (b) Direct current arcing and arc-quenching circuits (c) Sizes and types of direct current magnetic starters: (i) Counter EMF controllers (ii) Lock out controllers (iii) Magnetic time controllers (iv) Mechanical time controllers (v) Dynamic braking controllers

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AUXILIARY SYSTEMS AND EQUIPMENT

BLOCK 15: Miscellaneous Installations

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NOTE: Other systems such as burglar alarm, fire alarm, nurses call are not indicated above because they involve no techniques not required in the above indicated installations

AN ANALYSIS OF THE ELECTRICAL TRADE (CONSTRUCTION)

AUXILIARY SYSTEMS AND EQUIPMENT

BLOCK 15: Miscellaneous
Installations

UNIT 1: Communications Systems

OPERATIONS	KNOWLEDGE
<hr/>	
1. Installing annunciator system	(a) Sources of power for annunciator systems (b) Interpreting schematic diagrams
2. Lacing communications cable	(a) Colour coding of multi-wire cable (b) Methods and reason for lacing
3. Installing an interphone	(a) Types of rectifier power supplies e.g. vacuum tube, metal, half and full wave (b) Interpreting schematic diagram
4. Wiring a PA system	(a) Interpreting wiring diagrams

AN ANALYSIS OF THE ELECTRICAL TRADE (CONSTRUCTION)

AUXILIARY SYSTEMS AND EQUIPMENT

BLOCK 15: Miscellaneous
Installations

UNIT 2: Time Clock Systems

OPERATIONS	KNOWLEDGE
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1. Installing master time clock and program control	(a) Types of master clock systems: (i) Impulse type (ii) Electronic type (iii) Synchronous wired (b) Types of time recording systems: (i) Attendance recorder (ii) Job recorder (iii) Time stamp machines (c) Function and scope of program control (d) Separation of wires of different systems
2. Installing timed switches	(a) Types and ratings of time switches
3. Mounting trippers on timed switches	(a) Adjustment for on-off operation (b) Adjustments of minute selector trippers

AUXILIARY SYSTEMS AND EQUIPMENT

BLOCK 15: Miscellaneous
Installations

UNIT 3: Heating Apparatus

OPERATIONS

KNOWLEDGE

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- | | |
|---|---|
| 1. Wiring hot water heater | (a) Types of hot water heaters
(b) Proper installation of wrap-around heaters
(c) Location requirements for asbestos wire on heating equipment
(d) Series-parallel connection of two-element heaters |
| 2. Installing and wiring water heater thermostats | (a) Location and operation of thermostats
(b) Types and ratings of thermostats
(c) Function and operation of safety thermal fuses
(d) Circuitry of twin heaters and thermostats |
| 3. Wiring electric range or rangette | (a) Maximum wattage allowed on branch circuit conductors
(b) Necessity for grounding
(c) Three wire distribution system |
| 4. Installing underground heating cable | (a) Techniques in installing the cable
(b) Uses of underground heating cable
(c) Spacing of heater cable and watts per unit area
(d) Length of heater cable relative to the line voltage
(e) Methods of sealing off the end of the heater cable to render the cable moisture proof
(f) Methods of terminating cable in an outlet box |

